PATENT SPECIFICATION

1,037,665

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Mixing Device

WE, UNILEVER LIMITED, a Company registered under the laws of Great Britain, of Port Sunlight, in the County of Chester, England, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to mixing apparatus and in particular to mixing apparatus consisting of a conically shaped vessel which is provided with a stirrer on a vertical shaft.

The present invention provides mixing apparatus for pulverulent and/or liquid material comprising a cone-shaped vessel in which a centrally mounted stirrer is provided in the form of a right circular frusto-conical helical plate. The helical plate is formed in such a way that its thread has a continuously increasing pitch or lead and the width of the plate increases as the diameter of the cone-shaped vessel increases.

In a particularly preferred form of mixing apparatus of the invention the width of the plate and the pitch of the thread are such that there is a constant ratio between the area of the helical plate and the area of the vessel measured at the average height of the respective turn of the thread. This means that in this preferred form of mixer there will be a constant ratio between the area of the helical plate bounded by two horizontal cross-sections of the vessel and the area of the vessel at a third horizontal cross-section of the vessel midway between the two sections aforesaid. Generally this ratio is chosen so that the area of the helical plate covers substantially half of the area of the mixer. This ratio can be increased under special circumstances, for example high viscosity of the components to be mixed. Especially when mixing solids it is of advantage to increase the ratio to more than 50%.

If desired, the plate may be split along its length in two or more strips, provided the total of their surfaces covers half or more of the relative surface of the mixer, the distance between the strips being chosen such that the space formed will not be clogged.

The number of turns of the helix may conveniently be from 2 to 5 and is preferably 3.

A mixer of the invention may be used for powders and for liquids with a wide range of viscosity and for aeration as well as de-aeration of slurries, according to the direction of movement of the stirrer.

Apparatus of the present invention has the advantage that the construction of the vessel as well as that of the stirrer and the driving mechanism is very simple and that the mixing may be effected efficiently for a wide range of components.

In general, a drawback of equipment in which a cone-shaped vessel and a centrally mounted conveying screw are used is that incomplete mixing is obtained. Furthermore, adhesion to the side walls of the mixing receptacle occurs, especially when somewhat moistened pulverised materials are to be mixed. According to the invention this disadvantage can be eliminated by using a stirrer of the above-mentioned form, as a result of which, by reason of the decrease in volume between the side walls and the mixer blades when descending from the upper section to the lower section of the apparatus, an increase in shear-stress is obtained, resulting in a constant cleaning of the side walls and efficient mixing. It is preferred that the distance between the wall of the vessel and the helical plate remains substantially the same along the whole height

[Price 4s. 6d.]

of the vessel.

Embodiments of the invention will now be described with reference to the diagrammatic drawings accompanying the Provisional Specification of which:

Figure 1 is a cross-section of the apparatus for mixing pulverulent materials,

Figure 2 is a cross-section of the apparatus for mixing liquids.

Figure 3 shows a screw-stirrer in developed form,

Figure 4 shows schematically the action of the mixing device.

A further embodiment of the invention is also described with reference to the accompanying diagrammatic drawing of which:

Figure 5 is a cross-section of the apparatus with a double helical plate for mixing pulverulent materials.

In Figure 1 the wall of the cone-shaped vessel is denoted by 1; around the wall a heating jacket may be provided.

The shaft 2 is placed in the centre of the vessel and is connected to the spiral blade 5 of the stirrer by a number of rods 3 and 4.

The spiral blade 5 is made up of a number of turns, dependent on the nature of the material to be handled and on the residence time required for either batchwise or continuous operation. At the bottom of the apparatus a discharge opening 6 is provided. The distance between the turns and the wall of vessel 1 is substantially constant along the whole length of the blade 5.

The spiral blades are interconnected by a number of sloping rods 4, which pass through holes in the blades. Furthermore, horizontal rods 3 are provided which are connected to the sloping rods 4 or direct to the helical blades.

Figure 2 differs from Figure 1 in that the diameter of the discharge opening 6 is smaller. Instead of a slide valve in that case a stopcock can be used.

Figure 3 shows the way in which the helical blade can be made, for example, by cutting it from a single sheet of metal plate. The limitations for the cutting of the helical blade at A, B, C, etc. are determined by the dimensions of the discharge opening 6 and the maximum admissible pressure drop over the apparatus of the material to be mixed.

Figure 4 illustrates the action of the stirrer. In this Figure the direction of rotation is such that the material moves upwards at the side of the vessel. On account of the fact that the volume between two turns of the helix gradually decreases when descending from the upper part to the lower part of the apparatus, because of the decreasing width of the plate strip as well as of the decreasing lead of the turn, a suction takes place as the helix moves, which forces the material from the central part of the vessel to move radially outwards.

As shown in Figure 4 (left-hand part) the main stream, denoted by 1, moves downwards along the axis. A certain volume of the main stream is present between the two lower blades of the helix, a portion of it is lifted by the helix and after one turn of the helix said portion will replace a portion of stream 2 and occupy a fraction of the space available on the higher level. The thus replaced portion 2 moves in the direction of the centre and is mixed with the main stream 1. Consequently, material from section 2 moves downwards and outwards. After another turn of the helix the volume between the plate strips is partly filled with material from section 1 and section 2 and also replenished from section 3. In this way movements in horizontal and vertical directions are obtained. This construction enables every particle at any time to move vertically, radially and circularly; owing to the conical form of the vessel substantially no particle can ever follow any other. When powders are mixed the sliding angle of the material plays a role. In that case it is often advantageous, in order to effect more efficient mixing, to split the plate up into two or more strips with a space between, which space is chosen such that it cannot be clogged by the material.

Inevitably, also, leakage takes place when the material is lifted by the stirrer, which certainly enhances the mixing effect. The combination of the width of the strip, the leads of the turn and the angle of the cone should be chosen such that there is a constant ratio between the area of the helical plate and the area of the vessel measured at the average height of the respective turn of the thread.

The angle of the cone is preferably from 30° to 50°.

In Figure 5, the vessel 1 is supported on a framework 11, so that its cone apex points downwards. The apparatus comprises a stirrer consisting of two helical plates 5, constructed from a single helical plate split along its length and separated by 180° thus forming a double helix of downward decreasing radius which is supported by a number of sloping rods 4 connected laterally to the helices. Arms 3 are provided which support the stirrer from a rotatable shaft 2 disposed with its axis substantially along the axis of the cone-shaped vessel.

At the bottom of the apparatus is a discharge opening 6 within a slide valve 7, shown open, for discharging the contents of the vessel after mixing. The top of the vessel, being substantially closed by a cover 10, has an opening 8 for charging the

materials to be mixed, the opening being closed by a lid 9.

The shaft 2 passes through the cover 10 and is driven by means of an electric motor (not shown). The shaft 2 may be rotated in either direction, dependent on whether mixing or discharging of the vessel is required.

WHAT WE CLAIM IS:—

1. Mixing apparatus for pulverulent and/or liquid material comprising a cone-shaped vessel and a centrally mounted stirrer consisting of an axial driving shaft and stirrer blade in the form of a right circular frusto-conical helical plate, which blade is spaced from and supported by the stirrer shaft, the helical plate being formed in such a way that its thread has a continuously increasing pitch or lead and the width of the helical plate increases as the diameter of the cone-shaped vessel increases.

2. Mixing apparatus according to Claim 1, in which the width of the helical plate and the pitch of its thread are such that there is a constant ratio beween the area of the helical plate bounded by two horizontal cross-sections of the vessel and the area of the vessel at a third horizontal cross-section of the vessel mid-way between the two sections aforesaid.

3. Mixing apparatus according to Claim 2, in which the ratio between said area of the helical plate and said area of the vessel is at least 1:2.

4. Mixing apparatus according to any one of Claims 1 to 3, in which the helical plate is split along its length into two or more strips.

5. Mixing apparatus according to any one of Claims 1 to 4, in which the number of turns of the helical plate is from 2 to 5.

6. Mixing apparatus according to Claim 5, in which the helical plate has 3 turns.

7. Mixing apparatus according to any one of Claims 1 to 7 in which the angle of the cone-shaped vessel is from 30° to 50°.

8. Mixing apparatus substantially as described with reference to Figs. 1, 2, 3 or 4 of the diagrammatic drawings accompanying the Provisional Specification or Fig. 5 of the drawings accompanying the Complete Specification.

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FIG.1.

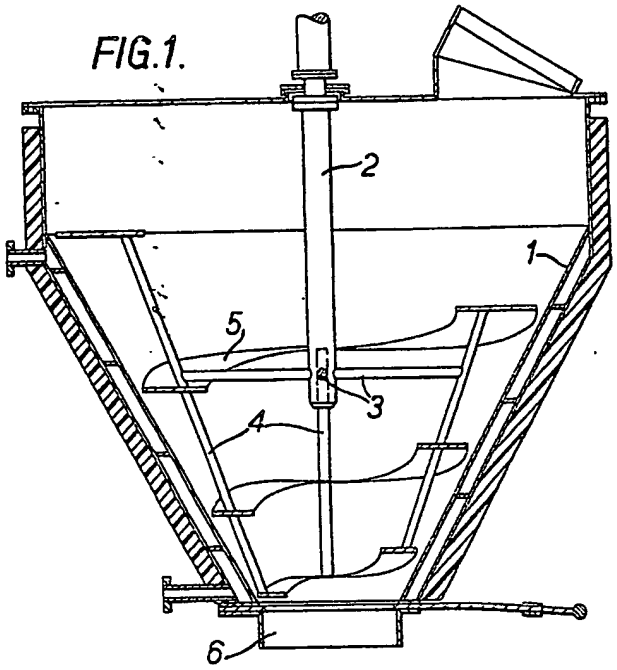
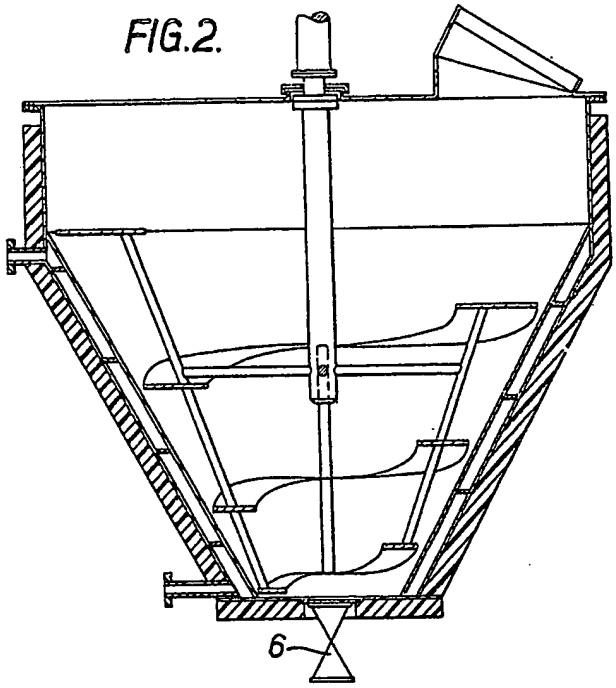


FIG.2.



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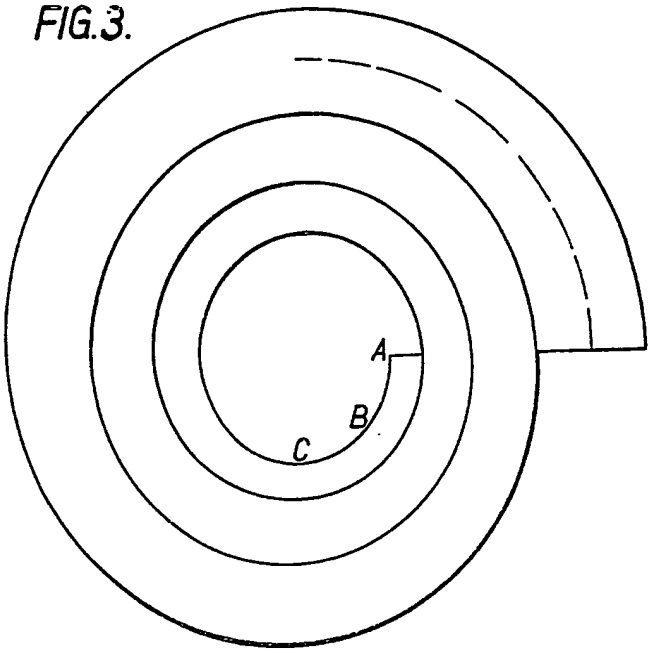
2 SHEETS

FIG.3.



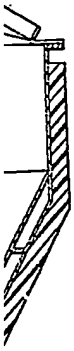
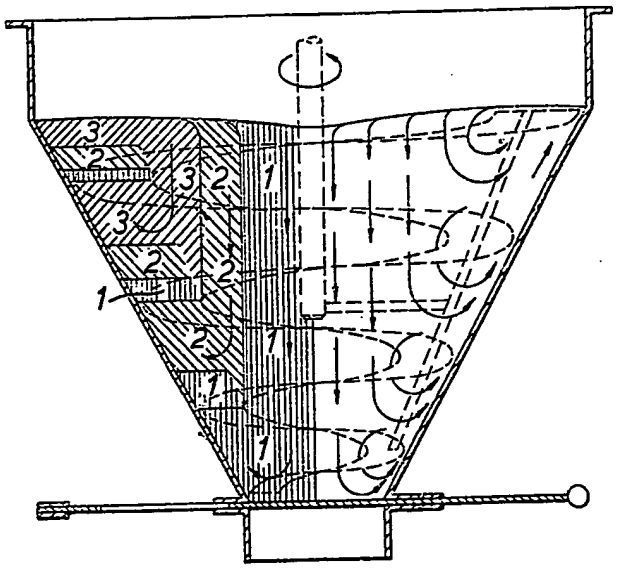


FIG.4.



1,037,665
2 SHEETS

PROVISIONAL SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

FIG.1.

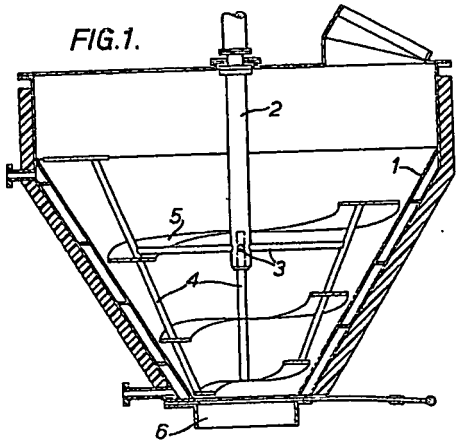


FIG.2.

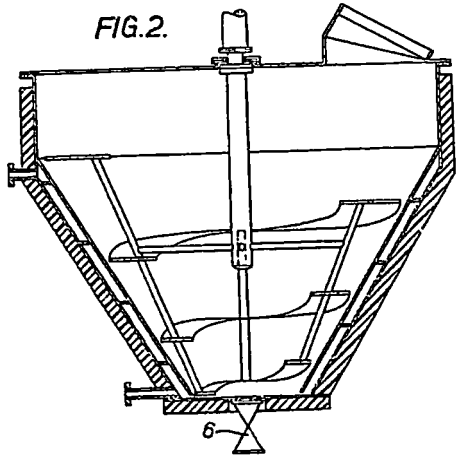


FIG.3.

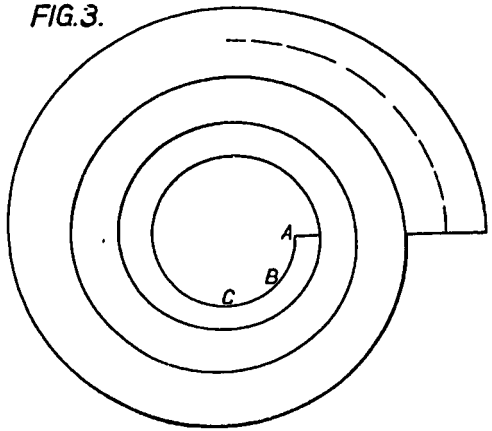
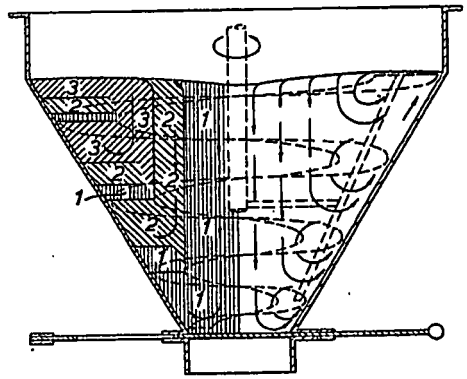


FIG.4.



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1 SHEET

FIG.5.